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Technology Validation Program for Mars Aerobot Micromission

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Overview: The *Mars Aerobot Validation Program (MABVAP)* was initiated in August 1997 to develop and validate key technologies needed for aerobot missions on Mars. The major elements of the program are the development of balloons for flight on Mars, robust techniques for deployment and inflation and modeling and simulation of balloon flight paths. selection, development and tests of available balloon materials, design and fabrication of balloons (both superpressure and solar- heated), design and fabrication of deployment and inflation systems for aerial deployment, design and fabrication of avionics to control deployment/inflation process and to get telemetry and video data.. Modeling of main processes during deployment and actual flight is also a part of MABVAP.

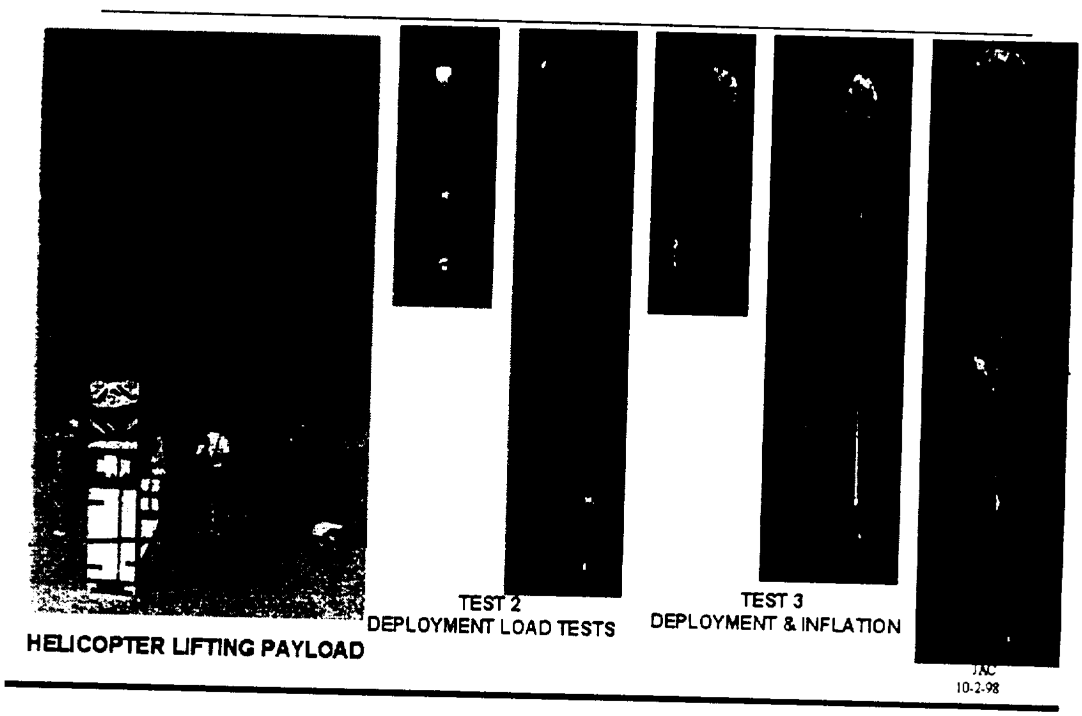
Approach: In order to validate deployment and inflation, MABVAP applies experience from previous Mars balloon development or study activities – the Russian-French Mars Aerostat Project (1988-1995), Mars Aerial Platform Study(1994) and Mars Aerobot/Balloon Study (1996). The program includes laboratory, wind tunnel, vacuum chamber tests of the system components and a number of tropospheric and stratospheric flight tests of deployment and inflation of light-film balloons in a simulated Martian environment

Key issues in the design include: the use of proven materials or their combinations; the availability of adequate balloon fabrication technologies and processes; evacuation of gas from the balloon prior to packaging and the design of a balloon container capable of storing the balloon over a wide range of ambient pressures. During the deployment process several considerations come into play: mitigation of forces on the balloon during deployment; a safe deployment process which does not tear the balloon; avoiding subsequent instabilities of the balloon including helium gas bulb propagation inside the balloon. Other key design issues include the necessity for a reefing mechanism for ensuring stable and predictable inflation of the balloon and the choice between top and bottom inflation.

Test Results: Tests that have been made at JPL and at the Vertical Wind Tunnel at NASA Langley Research Center clarified many of the first order issues discussed above and lead to the baseline configuration with inflation from the bottom without a reefing mechanism. The system is to be stable during the most critical part of inflation process. Although Karman oscillations may develop when the balloon is filled more than ~60% in volume the bottom inflation configuration ensures that these do not damage the balloon. Free drop tests of the inflated balloon at LARC and at JPL confirmed stability in the free flight.

To avoid possible damage of the balloon during inflation, a special diffuser/windsock has been designed to operate at hypersonic speeds. The system has been validated by inflating 12.5 mk and 8.5 mk 10-m diameter balloons in the vacuum chamber at 5 mbar ambient pressure. Volumetric rate of expansion was ~20 m3/sec.

A series of free flight tests of a brassboard deployment module from at an altitude of 1.5 km have been conducted with the payload dropped initially from a hot air balloon and in later flights from a helicopter. These tests were successful and demonstrated the shock mitigation approach and the stability of inflation of the balloon from gas cylinders beneath the balloon.



Stratospheric tests with simulation of Martian environment using a carrier balloon to raise the deployment module to ~35 km altitude are planned for the fall of 1998. A first test in the Gulf of Mexico was unsuccessful because of a carrier balloon failure.. Plans are being initiated for tests of a miniaturized system that would be compatible with the payload envelope for a Mars Micromission launched by Ariane 5. Development and stratospheric test of this miniaturized system could be conducted during the spring of 1999.

Other technology validation work planned during 1999 is focused on the development of a superpressure balloon envelope enabling extended lifetime for operation on Mars, miniaturized electronics and demonstrations of some of the key instruments in earth analog environments.